Uses of Echo in High Risk Obstetric Cases

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ABSTRACT
Focused cardiac ultrasound (FOCUS) is carefully investigated in this review article, which focuses on its use in the Obstetric Intensive Care Unit (OICU) and highlights the significant role that it plays in the treatment of pregnant patients who are experiencing cardiovascular problems. The physiological alterations that take place throughout pregnancy, the effects of conditions such as preeclampsia and hyperemesis gravidarum, and the benefits of employing echocardiography to check heart function and conduct direct fluid administration were all topics that were investigated by our team. Along with the challenges and limitations of echocardiography in fluid management, it is important to emphasize the necessity of understanding these changes in order to provide effective therapeutic action and improve the outcomes for both the mother and the fetus.

Introduction

ICU obstetric cases pose challenges due to altered physiology (Organization et al., 2005). Focused transthoracic echocardiography aids in diagnosis (Wilson et al., 2012). Various FOCUS exams exist: BEAT for trauma, FATE for critical care, RUSH for shock (Sharma et al., 2014). LTTE/ABCD assesses hypotensive patients (Gunst et al., 2008). LTTE-guided resuscitation improves outcomes (Gunst et al., 2008). Echocardiography aids management in critically unwell obstetric patients (Oren-Grinberg et al., 2013). Hemodynamic echocardiography directs resuscitative management (Marum et al., 2011). Quantitative assessment in echocardiography has limitations (Volpicelli et al., 2013). Training in focused echocardiography is recommended (Glaser et al., 2015).

Cardiac problems are a primary contributor to indirect maternal fatalities and significantly impact maternal mortality and morbidity in low and middle-income countries (LMICs). Prompt echocardiographic evaluation is crucial for detecting pregnant cardiac problems to facilitate prompt therapy and prevent mortality. Many hospitals in low-resource environments lack both the necessary facilities and cardiologists, or the diagnostic processes are excessively rapid to preserve the lives of critically ill cases (Oren-Grinberg et al., 2013).

Focused cardiac ultrasonography (FoCUS) may serve as an economical method for the rapid detection of cardiac problems in pregnant females in obstetric units in resource-limited environments. Obstetricians can be trained to obtain photos that can be analyzed remotely by specialists (Hashim et al., 2022). FoCUS5 is highly advocated for environments lacking conventional echocardiography or to enhance clinical evaluations for urgent medical decisions (Glaser et al., 2015).

The approach relies on the principle of 'task shifting,' wherein educated healthcare professionals, lacking prior knowledge, do echocardiography utilizing portable instruments and a simple imaging protocol. This approach has demonstrated efficacy in enhancing efficiency during initial clinical diagnosis, which can then be validated using standard transthoracic echocardiography (Hieda et al., 2018).

Currently, FoCUS is predominantly utilized in high-income environments within emergency medicine, anesthesia, and critical care. However, we identified several studies from low- and middle-income countries indicating that this methodology effectively screened and facilitated the early diagnosis of rheumatic heart disease in schoolchildren, even when images have been captured by non-specialists and interpreted remotely by experts (Abd ElRazik et al., 2024). Nonetheless, there is little evidence to support the diagnostic accuracy of FoCUS pictures of pregnant women obtained by skilled obstetricians and analyzed remotely by specialists (McParlin et al., 2016).

Physiological Changes During Pregnancy: Cardiovascular System Alterations

Significant anatomical and physiological changes take place over the course of pregnancy. Around the first few months of pregnancy, there are many large changes in cardiac output (CO). These fluctuations reach their peak around the fifth month of pregnancy and continue until the birth of the baby. The majority of this rise may be attributed to an raise in both the stroke volume (SV) and the heart rate (HR) (Wilson et al., 2012). There is also an increase in blood flow to various organs. The remodeling of the left ventricle takes occur in order to meet the increasing demands placed on the circulation (Marum et al., 2011). Estrogen and progesterone are two hormones that play significant roles in these modifications, which are regulated by neurohumoral and placental factors simultaneously (Wilson et al., 2012).

The relaxation of smooth muscle via the action of progesterone results in a decrease in vascular resistance (Ferrada et al., 2014), which in turn causes a decrease in blood pressure (BP) until the middle of the term, after which it begins to gradually climb (Volpicelli et al., 2013). Change also occurs to the volume of blood leads to increase number of red blood cells (Griffiths et al., 2018). Both the buildup of sodium and the decreased sensitivity to angiotensin II are factors that lead to an increase in the total quantity of water (Soma-Pillay et al., 2016) that is present in the body as well as the volume of fluid that is found outside of their cells (Karen Melchiorre et al., 2012) It is possible for edema to develop as a result of changes in the osmotic pressure of the colloid (Griffiths et al., 2018).

Cardiovascular changes after childbirth

Criteria for ICU Admission in Obstetric Cases: Identifying High-Risk Factors

Maternal health throughout pregnancy and the postpartum period presents distinct difficulties, frequently requiring admission to the ICU (Chauhan et al., 2023). The physiological and anatomical alterations that occur throughout pregnancy might worsen pre-existing medical disorders or trigger new ones, therefore complicating the methods for their care (Valensise et al., 2008). The frequency of obstetric ICU hospitalizations varies worldwide, often being documented as below 1%. Nevertheless, in contexts with limited resources, the percentages might be much higher, with several studies documenting rates as high as 16% (Melchiorre et al., 2013).

Admissions to the Intensive Care Unit for Obstetrics

Postpartum women are at a heightened risk of problems, making them more susceptible to being admitted to the ICU (Hieda et al., 2018). The mortality rates after admission to the obstetric ICU are much higher in locations such as Sub-Saharan Africa in comparison to industrialized nations (McParlin et al., 2016). Typical

reasons for admitting patients to the ICU include hypertension problems during pregnancy, bleeding, and sepsis (Gangakhedkar et al., 2021). Among these, hypertensive disorders are the most common cause Popa et al., 2021). The diagnosis and therapy of disorders like HELLP syndrome and eclampsia need a comprehensive strategy including several disciplines (Mitchell et al., (2017). This includes the use of medications and prompt delivery to minimize risks to both the mother and the fetus (Kochhar & Ghosh, 2018).

Predictors of Negative Outcomes in Obstetric Cases

Postpartum hemorrhage (PPH) continues to be a significant cause of maternal death worldwide, requiring immediate identification and care (Bolin et al., 2013). The management options primarily target uterine massage, fluid resuscitation, and blood product transfusion. Surgical measures, such as uterine artery ablation and cesarean hysterectomy, are only considered for instances that do not respond to other treatments (Salmon et al., 2009). Amniotic fluid embolism (AFE) is an uncommon but perilous illness marked by significant impairment of the respiratory and cardiovascular systems (Iftikhar et al., 2019). The diagnosis is depend on the clinical symptoms, and the main focus of treatment is providing supportive care and stabilizing the patient's hemodynamics (Weintraub et al., 2017). This approach is considered the foundation of management (Pathak et al., 2017).

Causes of Obstetric ICU admission (Thilaganathan & Kalafat, 2019).

Obstetric indication	**Non-obstetric indications Pre-existing diseases potentially worsened in pregnancy**	**High risk conditions due to pregnancy**	**Unrelated to pregnancy coincidental conditions**
Hypertensive-related pregnancy diseases • Pre-eclampsia • HELLP syndrome • Eclampsia	Autoimmune diseases • Myasthenia Gravis • Systemic lupus erythematosus • Autoimmune thyroiditis	Infections • Pneumonia • Pylonephritis	Trauma/car accident
Hemorrhagic conditions • Antepartum • Ectopic pregnancy • Postpartum	Cardiovascular diseases • Vascular heartdiseases • Hypertension	Thromboembolic disease • Pulmonary embolism	Appendicitis

	• Cardiogenic • pulmonary edema/shoc k Pulmonary hypertension • Arrhythmias (Atrial fibrillation/flutter) • Cardiomyopathies • Congenital heart disease	• Deep vein thrombosis	
Genitourinary Infection/sepsis Other conditions • Chorioamnionitis • Endometritis • Cardiomyopathy of peripartum period • Embolism of amniotic fluid • Acute fatty liver of pregnancy	Pulmonary diseases Neurological diseases Systemic diseases • Asthma • Diabetes mellitus • Epilepsy		Cholecystitis Rupture of intracranial aneurysm

HELLP, hemolysis, elevated liver enzymes, and low platelet.

Fluid Management in Obstetric ICU: Utilizing Transthoracic Echocardiography

Bedside focused transthoracic echocardiography is used as an adjunct to clinical assessment and basic investigations in critically sick patients. The objective is to detect major abnormalities such as decreased left ventricular ejection fraction, pericardial effusion, and indications of hypovolemia. This method allows for quick evaluation of heart function and fluid levels, which is especially useful for patients in the obstetric intensive care unit (Prin et al., 2019).

Echocardiography is used to estimate the cardiac output (CO).

Echocardiography enables the measurement of cardiac output without the need for invasive procedures. Cardiac Output (CO) refers to the total volume of blood pumped by the heart per minute. This is achieved by estimating the stroke volume (SV) using the aortic blood flow velocity time integral (VTI) and the cross-sectional area (CSA) of the aortic valve. This approach offers a dynamic evaluation of carbon monoxide (CO), which is crucial for determining the appropriate fluid treatment for patients in critical condition. This helps in quantitatively assessing a patient's cardiac function, optimizing vasopressors and fluid resuscitation in critically ill patients and distinguishing between different types of undifferentiated shock in critically ill patients (Witteveen et al., 2017).

Assessing Fluid Responsiveness in Obstetric ICU Patients: Static vs. Dynamic Parameters

Echocardiography yields static measurements such as the left ventricular end-diastolic area (LVEDA)

and dynamic measurements such as the respiratory fluctuations in aortic blood flow velocity (ΔVmaxAo). These factors assist in evaluating the initial volume of blood in the heart and anticipating the ability of the body to respond to fluid administration, which is essential in optimizing the administration of fluids in obstetric intensive care unit patients (Siaw-Frimpong et al., 2021).

Variations in the diameter of the vena cavae.

Current attention has been directed on using differences in the diameter of the superior and inferior vena cava to evaluate the level of fluid volume in the body. The alterations in the diameter of the superior vena cava (ΔSVC) and inferior vena cava (ΔIVC) due to variations in respiration have been shown to be associated with fluid responsiveness (Koukoubanis et al., 2021). This correlation offers supplementary methods for managing ***fluid levels in patients who are critically sick (Russell et al., 2020).***

Significance and Difficulties of Echocardiography in Fluid Management

Although echocardiography provides useful information on fluid responsiveness, there are still obstacles to its broad use. Dynamic parameters such as ΔSVC have potential in forecasting FR, however, a considerable level of expertise is necessary for precise evaluation (Guntupalli et al., 2015). In addition, it is important to note that not all patients show a positive response to fluid administration, even when dynamic indicators imply otherwise. This emphasizes the need of adopting a comprehensive strategy to fluid management in obstetric ICU patients (Clark et al., 2014).

Lung ultrasound integration

Lung ultrasonography enhances echocardiography by evaluating pulmonary edema and providing guidance for fluid treatment based on the detection of B-line artifacts, which indicate elevated extravascular lung water (Finfer et al., 2018). This integrated method provides a complete strategy for managing fluids in obstetric ICU patients, with the goal of optimizing hemodynamic stability and reducing the risk of fluid overload (Tkachenko et al., 2021).

Effects of Intensive Care Unit (ICU) Admission

Trends in Maternal Mortality Worldwide

Maternal mortality continues to be a substantial issue in public health, mostly affecting poor nations. While there has been a decline in maternal death rates between 1990 and 2015, the progress made did not meet the objectives set by the Millennium Development Goals. The objective of the sustainable development objectives is to decrease the global maternal mortality ratio to below 70 per 100,000 live births by the year 2030 (Anthony & Schoeman, 2013).

Subject: Near Miss Maternal Mortality (SAMM) and Critical Care This message pertains to the topic of Near Miss Maternal Mortality (SAMM) and its connection to critical care.

Severe acute maternal morbidity (SAMM), sometimes known as "near miss maternal mortality," is more widespread than maternal death (Ismail et al., 2020). Comprehending and treating SAMM patients are vital for diminishing maternal mortality rates. Utilizing critical care management concepts is crucial for improving

outcomes in critically sick obstetric patients who are hospitalized to intensive care units (ICUs) (Malbrain et al., 2018).

Influences on Maternal Outcome

Various variables, including as delays in seeking medical attention, accessing suitable healthcare facilities, and obtaining sufficient therapy, impact the outcome of obstetric patients admitted to ICUs (Nagar et al., 2023). These delays are influenced by sociodemographic characteristics, the availability of healthcare facilities, and the level of treatment provided (Malbrain et al., 2018).

Effects of Referral and Socioeconomic Status

Patients who are admitted to the ICU and originate from lower socioeconomic backgrounds often have worse results. Patients who are referred may have a greater risk of complications or be in critical condition, which may lead to worse results (Singh et al., 2023). The health-seeking behavior and use of prenatal care are influenced by socioeconomic status, which in turn has an impact on the outcomes for both the mother and the fetus (Langer et al., 2019).

Significance of Prompt Intervention

Prompt intervention is essential in obstetric crises to enhance patient prognosis (Anthony et al., 2013). Procrastination in seeking medical attention, exacerbated by cultural and logistical obstacles, exacerbate the results (Rudloff et al., 2021). Delay, particularly during the decision-making phase, is linked to worse results (Adamik & Yozova, 2021).

Typical reasons for admitting a patient to the Intensive Care Unit (ICU)

ICU hospitalization is often required for obstetrical bleeding and hypertension diseases (Scolletta et al., 2016). Nevertheless, there is variation in the documented signals across various research, which is impacted by regional and socioeconomic characteristics (Vincent et al., 2015).

Effect of APACHE II Score and Delay

Patients who postpone seeking treatment had higher APACHE II scores, which indicate greater illness severity (Hany et al., 2018). Extended periods of waiting are linked to higher death rates. The presence of logistical limitations and problems with healthcare infrastructure in medical institutions might potentially lead to death rates that surpass the anticipated values (Anthony & Schoeman, 2013).

ICU Admission Practices Variability

Hospitals exhibit significant heterogeneity in their ICU admission procedures, which are impacted by factors like as geographic location and socioeconomic level. Individuals residing in urban areas and individuals with lower socioeconomic level have a higher likelihood of being admitted to intensive care units (Leibowitz et al., 2020).

Risks to the developing fetus in pregnant women with critical illness

Pregnant women who are in a critical condition present dangers to the health of the fetus as a result of the mother's sickness and the interventions performed in the intensive care unit. Maternal shock, hypoxemia, medication treatment, and radiological tests are among the factors that contribute to fetal hazards. It is important not to refrain from providing necessary treatments to the mother owing to worries about potential consequences on the fetus (Franchi et al., 2017).

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